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ABSTRACT

This paper focuses on the status of science teaching and learning in 20 secondary schools in an urban community which caters to an extremely diverse multicultural student population and the research needed to improve science teaching and learning in such a setting. This research was conducted to provide pre-service teachers with an insight into the realities of teaching and learning in an urban setting. The areas discussed include: (1) attitudes and concerns of urban science teachers; (2) the secondary science curriculum; (3) attitude of urban students to science; (4) strategies for improving science education; (5) out of school projects aimed at making science relevant; and (6) research needed to improve science teaching and learning. Data were collected from 200 students, 50 science teachers, science teacher associations, the Department of Education, journal articles, and science educators. (Author)

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Towards an Appropriate Agenda for Research and Action:

Preservice science teachers' views of urban high schools

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ABSTRACT

Towards an Appropriate Agenda for Research and Action:

Preservice science teachers' views of urban high schools

The paper focuses on the status of science teaching and learning in twenty (20) secondary schools in an urban community, which caters to an extremely diverse multicultural student population and the research needed to improve science teaching and learning in such a setting. This research was conducted to provide pre-service students with an insight into the realities of teaching and learning science in an urban setting.

The areas discussed include

1. Attitudes and concerns of urban science teachers
2. The secondary science curriculum
3. Attitude of urban students to science
4. Strategies for improving science teaching
5. Out of school projects aimed at making science relevant
6. Research needed to improve science teaching and learning.

Data were collected from 200 students, 50 science teachers, science teachers associations, the Department of Education, journal articles and science educators.

Towards an Appropriate Agenda for Research and Action:

Preservice science teachers' views of urban high schools

The paper focuses on the status of science teaching and learning in an urban community, which caters to an extremely diverse, multicultural student population and the research needed to improve science teaching and learning in such a community. This research was conducted as part of their methods course to provide pre-service students with an insight into the realities of teaching and learning in an urban setting. It was felt that pre-service teachers ought to be exposed to the realities of teaching science in the district in which they were aspiring to teach.

Teachers collected information from 20 secondary schools on

a. Attitudes and concerns of urban science teachers

b. The current secondary science curriculum

c. Attitude of urban students to science

d. Strategies for improving science teaching

e. Out-of-school projects aimed at making science relevant

This was presented at a seminar,the theme of which was "Science Teaching and Learning in an Urban Community". Included here are abridged versions of the presentations.

Attitudes and Concerns of Urban High School Science Teachers

The concerns of high school science teachers include professional, legal,labor and political issues. In an effort to narrow down the focus of this paper ten public high schools were visited and issues of concerns were discussed with science teachers. In order to encourage open-minded discussions on a variety of topics,no structured surveys of any kind was conducted. The focus was on issues pertinent to science teachers. The procedure included tours of schools, classroom observations and candid discussions with science teachers. Although these teachers varied fairly widely in teaching experience, personal circumstances and socioeconomic status, several issues were repeatedly cited by them as being important in their teaching experiences. These issues turned out to be the following: professionalism in teaching; day-to-day classroom experiences; teacher education and training. This paper attempts to come to grips with the three issues which emerged from the discussions.

1.Professionalism in Teaching

Teachers were unanimous in their desire to achieve a high degree of professionalism in science teaching. However, the degree of professionalism which teachers desire is yet to be achieved. This fact is borne out by many characteristics of science teaching in the schools surveyed. Goodlad (1984) states that the practicing teacher functions in a context where beliefs and expectations are those of a profession,but where realities tend to

constrain, likening the actual practice of teaching more to a trade. By its very nature, a profession involves both considerable decision making; and knowledge and skills developed before entry and honed in practice. The teachers in Goodlad's study encountered in schools many realities not conducive to professional growth.

As noted by Ryan and Cooper (1972) teachers, as a professional group, are very low on the totem pole as far as decision-making poweris concerned. For example, teachers do not evaluate their peers: administrators evaluate teachers; teachers do not have much say in the pre-service training of teachers: university professors do that; teachers do not control the licensing and certification of teachers: bureaucrats do that. In addition, teachers have very little input in deciding the curriculum for any subjects to be taught. Goodlad, Ryan and Cooper's findings all hold true for the teachers in this study.

In the schools studied teachers are required to be in the school building at a certain time each day, regardless of their class schedule, and are required to maintain time cards. According to the teachers however,the length of their working day and week is a far more complex matter than having to be in the schoolbuilding at a certain hour. Goodlad (1984) found it difficult to put together a composite picture of the working week for teachers in his study. Taking into account planning lessons, correcting papers and examinations, reporting student attendance, going to meetings, conferring with parents and providing various kinds of data for school records, in addition to actually teaching the class, a work week of up to 50 or even more hours is possible. In this light, it is evident that secondary school teaching has very little of the flexibility associated with a profession.

Another important aspect associated with a high degree of professionalism is active participation in various scholarly organizations. None of the teachers who expressed an interest in this type of activity did, in fact participate in any of the commonly known professional organizations, such as the National Science Teachers Association, the National Association for Research in Science Teaching or the American Association for the Advancement of Science. The teachers all cited a lack of time as the only reason for non-participation in these professional associations.

2. Day-to-Day Classroom Experiences

Secondary school science teachers seem to regard the classroom, as opposed to the school, as their real workplace. All of the teachers interviewed liked and took seriously the control they have over how they teach their classes. Many of them expressed a desire to have fewer constraints placed upon them from, in particular, the State Board of Regents. Some teachers stated that they often find themselves sacrificing personal creativity in their teaching, in order to teach a state-mandated set of topics by the end of the academic year. Accordingly, Goodlad (1984) found that teachers who found their jobs to be highly satisfying also tended to report high levels of control in how they carry out their jobs.

Unfortunately, the teacher's classroom efforts are often hindered by overburdening the teacher with various non-academic duties. The teachers cited various non-professional activities such as the monitoring of restrooms, lunchrooms and hallways as occupying a sizeable part of each day. The time teachers must spend in these non-academic roles takes time away from academic activities such as lesson preparation, duplicating materials, and reading professional literature. In addition, these non-academic duties make peer

discussions and interaction with students, administrators and teachers less likely.

3.Teacher Education and Training

Most teachers approved of requiring graduate coursework for teacher certification, but felt that a great deal of the theory they learned in graduate school was inadequate to meet the needs of their everyday teaching experiences. Teachers expressed the view that teacher education courses are too theoretical and have little relevance to classroom practices. Many of the complaints were related to the difficulty involved in converting the education courses into a survival kit for the classroom. This is an important reason for the benefits inherent in professional organization participation during a teacher's career.

The negative attitude and disparaging comments of many college professors combine with the theoretical teaching models learned in graduate education courses can cause a prospective teacher to develop uncertain attitudes towards science education, and as a result, to become frustrated in the early teaching experiences. Dobson and Dobson (1983) emphasize the importance of teachers developing and understanding their own values and beliefs about schooling. Dobson and Dobson argue that since people create their own belief systems, and that the belief systems affect the attitudes of a person, it is necessary that teachers' actions reflect their own feelings and attitudes. Teaching practice, without the support provided by a well-developed set of beliefs, leads to teaching without purpose. According to Goodlad (1984), there exists a marked discrepancy between the values dominant in teacher education courses and those more frequently found among practising teachers.

The issues addressed indicate that improving science teaching and learning in this community will require adequate attention to the attitudes of the school system's teachers. The teachers interviewed all value education very highly, and advocate changes in the system that would improve the quality of education.

The Secondary Science Curriculum

Thirty years ago, the launch of a small satellite condensed a theretofore diffuse anxiety about the U.S. scientific and technological capability. Current and future science achievement was questioned, and an urgent national goal for school science was spawned: produce top-notch career scientists. In order to meet this goal, curricula were developed that encouraged traditional modes of scientific thought within the established disciplines. The impetus for science education today is very different. Fears that the nation's technological superiority is eroding are accompanied by anxiety concerning our ability to maintain a healthy, expanding economy and to compete successfully in the world market. The type and variety of concerns suggest that a single goal of producing career scientists is no longer adequate or realistic for school science.

Many goals have been proposed: a productive work force, a literate citizenry, widespread adoption of the intellectual style of scientists, which is equated with better thinking ability; and a greater ability to apply social, ethical and political perspectives to interpretations of scientific information. These goals are different from those of the 1960's in that they encompass science competence for all students, regardless of sex, race or economic status.

Although the goals for school science programs have shifted from career scientist to productive work force, literate citizenry and the intellectual style of scientists; the content or the curriculum emphasis has not really changed. The content of school science curriculum has been mainly derived from textbooks. The persistent and recurrent themes found focus on particular theories of learning and the nature of the learner and on content expectations that embody implicit assumptions about the acceptable nature of reality. The specific content has been Life Sciences, Physics, Chemistry, Earth and Space Science with the content focussing on the technological, societal, personal and scientific contexts, and the cognitive skills involved revolving around the student knowing, using, and integrating the content.

The content refers to the coverage of particular topics, processes and skills, and is derived mainly from textbooks. Despite small differences in specifics, plans of knowledge development that progressed from the concrete to the abstract were apparent in all the textbooks, and whether the approach to presenting this information varied, the message was explicitly stated in the teacher's editions of books or in preambles to individual curriculum design. The lessons are designed to present information in contexts that progressively advance from concrete to abstract, and are based on theories that hold that pupils' cognitive ability to conceive of and manipulate abstractions develops to maturity during those years and that learning is enhanced by lessons designed for each stage of that process.

The second significant content theme is found in that science lessons require the same cognitive rules -

analytic abstraction (instructs the user to find hidden properties, name them, and give them meaning in themselves) and

field extraction (requires that the pupil separate himself as observer from his field of observation and then impose structure on an ambiguous field)

to locate content and to do standardized intelligence and achievement tests.

This theme is so persistent in all of the science materials that extracting appears to be seen as the heart of current concepts of scientific objectivity and as the basis of control of one's external world.

The basic material used in the present curriculum approach is the textbook. The major emphasis of this material is to provide content. These text materials are very ineffective in the development of the talent necessary for a rapidly changing society.

All other science materials such as field trips, computer simulations and videos help support the standardized tests (SAT, Regents) as a measure of one's intelligence. These materials do very little to motivate the individual to pursue his specific interest and/or desires. Until the approach to science changes, and the materials that support that approach change as well, science students will be assessed according to their test scores, and very few will progress to the higher sciences.

The major criteria of the curriculum has been on content with emphasis on concrete-to-abstract and the development of skills associated with Analytic Abstraction and Field Extraction. But what are the "hidden messages" that are demonstrated by the teacher's approach? While observing at one school, the underlying emphasis toward studying science

was that the students learn to distinguish between direct and indirect evidence. The overall emphasis was to illuminate the differrences between observations and inferences and to show how these function within science. These "hidden lessons" were purposely intended so that they clarify the way science can be used in the making of practical decisions. For example, when the subject matter "Properties of Materials" was covered the objectives dealt with specific properties such as color, size and texture, but the meta-lesson objective that the students were to ascertain was the distinction between "natural properties" and man made features of a particular object. The pervasive overall aim of the unit is for the student to learn to distinguish between the role of knowledge and the role of values when making a practical decision. The school observed was an "ART" oriented school which did not emphasize the sciences as knowledge base, but as necessary for producing students who can make good, sound practical decisions based upon direct vs indirect evidence.

The distinction between the two types of evidence are supported with numerous labs which allow the students to have contact with direct evidence. Although this approach was demonstrated, the strength of the text and its use as the curriculum emphasis is so pervasive with regard to scoring well on Standardized and Achievement test, that it amounts to an insignificant "Meta-lesson".

The present curriculum emphasis has been on content, (K-6) concrete-to abstract and then (7-12) analytic abstraction and field abstraction. This curriculum approach was geared to Full Scientific Capability, to develop career scientists. This approach was excellent with regard to standardized tests (SAT, Regents) but not for a technological society. The

emphasis of examinations must be re-evaluated. If the new emphasis "Full Technological Capability"is to be introduced, examinations as they now exist will be obsolete. New methods of evaluation will also have to be established, to include creativity and project work.

Attitude of Urban Students to Science

This study was undertaken in three schools to determine the general attitude of students towards science classes and to serve as a pilot study for a larger project which will focus on student attitude and interest in science as a school subject and as a career goal and would include a more comprehensive cross-section of the school population. The sample comprised students enrolled in science in the first term of high school with representatives from the white middle class and minority population. The results provided answers to the following questions:

Is science one of your favorite subjects?

75 % listed science as their favorite subject, those who listed it as their least favorite did so because they did not understand the material that was presented to them.

What are some of the enjoyable features of a good science class?

Laboratory activities that work, interesting topics, having the material presented in an understandable manner were some of the features listed by students.

What do you plan to major in after high school?

Psychology and business were listed as preferences by most of the female students for college majors, few were interested in science. Is it possible that even though female students like science in the early phase of their high school, they percieve pursuing a career in a "hard science" as too difficult a task?

Reactions to participation in Science Fairs.

Results indicate that when their schools participated in science fairs 34 % of the participants are willing, 40 % are bystanders while 26 % are unwilling to participate. Based on the results of this limited survey the following questions arise:

Why are women choosing psychology and business, but neglecting as a group the possibility of a career in science?

What are the implications for our society if our educational system cannot provide the technically skilled professionals for the future?

How can the curriculum be restructured to attract more women into science?

Do we need a general campaign to change students' perceptions of science?

These questions and many more need to be examined more closely if we hope to make science more accessible to all students.

Strategies for Improving Science Teaching

Scientific groups predict that lack of student interest in science will translate into a shortage of scientists in the future. This shortage will impact negatively in many areas, from national defense to high technology to economic productivity. What can the science teacher do to increase interest in science? What are some of the obstacles to teaching science in an urban setting?

A) Student related obstacles:

-Teenage pregnancy: Many students are single parents and some of them already have one or two children.

-Unstable family situation: Causes of this instability range from divorced parents to drug addiction and unemployment. More recent problems include crack and AIDS. As a consequence of these problems students are often depressed and frustrated.

-Poor attendance: This is the most important problem in our public high schools. Poor attendance is related to the student's social situation and lack of support at home and among peers.

-Student interest: Students are interested in subjects that are immediately related to their life situations. It is relatively easier to get students involved in writing about or discussing their own experiences than to teach them the structure of an atom.

B) School related obstacles:

-Lack of science equipment: Most science classrooms are without gas and running water.

-Textbooks: Most of the textbooks used in science are confusing and unstimulating. The majority of the experiments and demonstrations described do not work as expected. Directions are often unclear.

Effective Strategies for Teaching Science

In order to improve science teaching, teachers must tailor their strategies to fit the problems of their particular students. Teaching is much more than learning certain skills and applying them. Teaching involves emotions and personalities.

The strategies discussed here were used by the panelist in a Junior High School and an alternative high school.

A) Lecturing:

This technique, used alone, was ineffective in science classes at the alternative high school.

B) Questioning:

This was combined with short explanations. Questioning stimulated students' thinking and enabled the teacher to lead the students into the explanation of new concepts. Questioning was found to be one of the most important aspects of teaching. Students were motivated when asked the right kind of questions. It was also useful to write out some questions with the lesson plan; in this way it was possible to incorporate recall, comprehension, application, analysis, synthesis and evaluation questions. Students were more motivated when the questions had been prepared beforehand.

C) Demonstrations:

Demonstrations were found to be among the most useful techniques in these classrooms. Even though demonstrations cannot replace labs, they adapt well to the problems in a public school. In most public schools there is a shortage or lack of science equipment, classrooms are used most of the time so there is little time for preparing labs prior to class.

D) Laboratory:

The major impediment to this method was the preparation time required. This combined with the shortage of equipment made it an effective strategy although it was recognised by the teacher to be a necessary component of science teaching.

E) Logs:

One of the most powerful tools that people have is the ability to write well. Having students write science logs every other day helped them to express and understand what was taught. Log grades were based on the effort the student put into explaining what was learnt. This was found to be one of the best techniques for evaluating what students understood.

F) Brainstorming:

This is a basically a brainstorming between two students. This strategy was used to recall information previously discussed in class and to learn new information from their peers. This technique can provide a useful stepping stone to a new concept.

G) Students as teachers:

Students who already understand the concept explain it to the rest of the class.

H)" Social strategies":

It is important to develop a relationship with each student. Building up a trusting relationship can help students open their minds to learning. The following lists some

strategies which were useful in these two schools:

-Always give students a second chance.

-Talk to the students on a personal level.

-Apologize to the students if you have done something wrong or if you have made a mistake.

-Talk with other teachers about your students.

-Compliment students if you know they are doing well in other subjects.

-Find positive comments about them, but also find the opportunity to tell them what they are doing wrong.

-Ask for feedback and ideas of ways that they would like to learn.

-Be strict but flexible.

-Be consistent but use common sense.

-To the extent that you feel comfortable, share details about your private life.

The guiding principle behind these strategies should always be that the function of the science teacher is to let the students have "fun" while learning science.

Out of School Projects Aimed at Making Science Relevant

Relevant science projects outside the classroom can be one of the most exciting and wonderful learning experiences for students. "To children growing up in New York City, it may seem that fruits and vegetables are grown in supermarkets, that trees are street decorations set 30 feet apart on the sidewalk and that plants are native to small ceramic pots dotting the windowsill." (New York Times, Sept. 1989)

Making science relevant outside the classroom is becoming a common goal for many organizations, teacher groups and corporations. New York City offers the science teacher a grand selection of places to visit in order to accomplish this goal.

a.The Brooklyn Botanic Gardens recently opened its new Chase Manhattan Discovery Center. This center has exhibits, games,and self-guided demonstrations. At the center of the room,there is a large replica of an oak tree that has been hollowed out. As children walk through the model, they observe the residents of an oak tree, which include a chipmunk, squirrel, owl, and rabbit. Compartments in the bark reveal insects. Food and plant relationships are demonstrated to children in various ways. Supermarket items like ketchup are related to tomatoes, and celery is related to celery soup. Wood grains and growth rings are demonstrated through cross sections of branches.

The Brooklyn Botanic Gardens also has a children's gardening program. Children ages nine through eighteen attend classes once a week on Saturday during spring and twice a

week during summer. The program encourages children to work in pairs in planting, hoeing, watering, weeding, and harvesting their own 15' x 4' plot of land; lessons are taught each session on the chore for the day. If the children have to mulch around their plants, the importance of soil moisture and weed control are discussed prior to any activity in the field. Children then go out to their plots to do the required activity. They may not realize the importance of their action immediately, but in a few weeks, they will observe a noticeable decrease in the amount of weeds around the base of their plants, as well as a decrease in the amount of watering required.

b.Gateway National Recreation Area has many valuable programs that help to make science relevant. One such program is Ecology Village Camping at Floyd Bennett Field in Brooklyn. Children explore the marine life and ecology of Jamaica Bay, discover local flora and fauna, and spend their nights in tents. In order to participate in this program,group leaders are required to attend a workshop that includes an overnight stay. The workshop teaches group leaders the necessary safety requirements involved in camping, in addition to the educational background necessary for their stay.

c.The Central Park Zoo is an excellent place to take students on a field trip. The topic of animal adaptation can best be described in a zoo setting. The zoo is designed so that animals representing the various zones (tropic, temperate, artic) are located together. This design allows students to recognize adaptations that are necessary for survival in each zone.

The zoo also has a Zoo School which holds numerous classes on wildlife education.

d.The New York Aquarium Discovery Cove offers a comprehensive introduction to ocean life. The cove has push-button demonstrations, photographs, participatory games, and video terminals that allow the student to become involved with the aquatic world. It gives students the opportunity to view various ocean environments like the sea shore, the marsh land, the rocky coast and a 45' tank which demonstrates wave action and the effects of waves on the shore line. The aquarium also offers many school group classes, as well as weekend classes for ambitious students.

These are four of the many programs students can get involved with in New York City. However, making science relevant outside the classroom does not have to revolve entirely around museums, zoos, and on-going educational programs. The New York City area has many places that can be adapted to teach almost any discipline in science. Science outside the classroom excites and stimulates students' curiousity to learn a topic in its natural environment.

Appropriate Research and Action Agenda

The science teaching and learning situation as viewed by pre-service science teachers points to a need for research and action in the following areas if science teaching and learning in this urban setting is to be effective:

a: Introducing a curriculum emphasis aimed at developing a productive work force, a scientific literate citizenry and meeting the needs of the gifted as well as those who need science only for dealing with "persistent life situations".

b: Teacher training focussed on the acquisition of skills to teach mixed ability,mixed interest students who are economically, culturally and ethnically diverse.

c: Introducing changes in the system for increasing professionalism among teachers and the quality of education.

d: Providing elementary and secondary students with interesting and enjoyable science experiences, which would stimulate their interest in continuing to study science and in pursuing careers in science..

e: Developing science text materials which would assist in developing the talents necessary for a rapidly changing society.

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